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Light Fidelity: The Future To The Wireless Data Communication

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ABSTRACT: *Radio Frequency (RF) communication suffers from congestion, interference and high latency issues due to large number of users. Overcoming these limitations, Light Fidelity Technology is a preferred communication technique because of its high bandwidth and immunity to interference from electromagnetic sources. Li-Fi is a method of communication in which we transmit data using visible light region of electromagnetic spectrum with the help of Light Emitting Diodes (LEDs).It is a green communication method as it can attain data transmission by reusing the existing lightning infrastructure. The world can connect to internet where ever they find light, be it in schools, colleges, offices, aircrafts, roads and almost everywhere because there are rare places where light is not present. This paper presents the working principle of Li-Fi, its potential applications, modulation techniques, misconceptions of Light Fidelity and comparison with Wi-Fi*
KEYWORDS: *Light Fidelity (Li-Fi), LED, Modulation Technique, Wi-Fi*

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I. INTRODUCTION

The number of devices accessing the Mobile network data and application services are increasing exponentially. The radio frequency bandwidth currently in use is a limited resource and puts constraints on the increasing demand for high capacity and connectivity. There are some electromagnetic spectrum of which its frequency band width are not utilized such as the visible light, Visible light is a range of electromagnetic spectrum visible to the human eye, having wavelengths of about 390 to 700nm and frequency bandwidth of about of 430 to 770 THz. The size of the infrared and visible light spectrum together is approximately 2600 times the size of the entire radio frequency spectrum of300 GHz as shown in fig 1 and they are high speed wireless data transmission (Harald Hass, 2018).

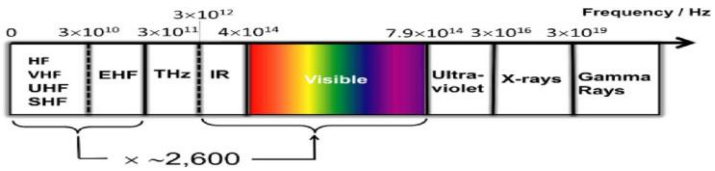

Fig 1 Electromagnetic Spectrum (Harald Hass, 2018)

The world can meet 20 years data demands using small percentage of the entire visible and invisible light spectrum. Light Fidelity (Li-Fi)is a technology in which data are transmitted in the visible and invisible light region of electromagnetic spectrum using Light emitting diode. Most commercial LEDs are white LEDs whose bandwidth are 2 MHz but the phosphor in it slows down the frequency response. However, it is possible to achieve data rates in the region of 1 Gbps with these devices. More advanced red, green and blue (RGB) LEDs enable data rates up to 5 Gbps. This technology transmits data by modulating the intensity of the light particularly switching it ON and OFF at a very high speed such that its changes are not detected by human eye. Since light is a medium for transmission, it cannot travel through the walls making it more secure than other wireless data technology (MahendraR.,2016). Its a high speed bi-directional network and because of its very

short range technology, it can become a complementary technology operating alongside with other Long Term Evolution (LTE) and Wireless Fidelity (Wi-Fi) access technologies in handling data and reducing the congestion on radio frequency spectrum. It creates no interference. Li-Fi coverts light into an electrical signal and the signal is converted back into data. Li-Fi supports user mobility and multiuser access.

II. THEORY

Li-Fi is a data communication medium, which uses visible light between 400 THz (780 nm) and 800 THz (375 nm) as optical carrier for data transmission and illumination. It uses fast pulses of light to transmit information wirelessly. The main components of this communication system are a high brightness white LED which acts as a communication source and a silicon photodiode which detects the signal serving as the receiving element as shown in Fig 2.

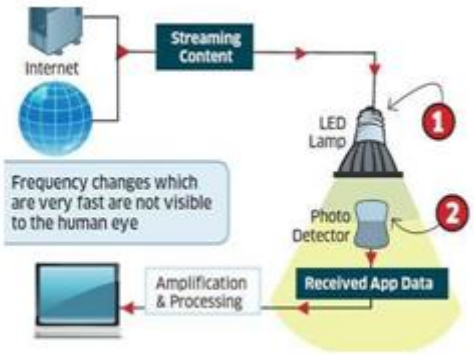

Fig 2. Li-Fi System (

Data from the sender is converted into byte format and then converted into light signals which are emitted by the LED. As soon as LED starts glowing, photo detector on other end will detect light and get a binary 1 otherwise binary 0(Ashwini et al,2016). The signal is amplified and processed. System Implementation involves using white LED light bulbs typically at the downlink transmitter for illumination only by applying a constant current. However, by fast and subtle variations of the current, the optical output can be made to vary at extremely highs peeds. This very property of optical current is used in Li-Fi setup. The LEDs can be switched ON and OFF very quickly, which provides apparent opportunities for transmitting data.

1. LI-FI MODULATION TECHNIQUES

LED has a very interesting property that enables its intensity to be modulated at very high speed. It can be switched ON-OFF at very high speed that even the human eye cannot detect which makes the output constant.
Implementation of a Li-Fi system can apply the following techniques:

a. On-Off keying (OOK): This is an amplitude-shift keying (ASK) modulation that represents digital data as the presence or absence of a carrier wave. The data is conveyed by turning the LED OFF (digital 0) and ON (digital 1). In OOK, the LED is not turned completely off in the OFF state, but the reduction in the level of intensity is performed. It is simple to generate and decode. It also provides a good trade-off between system performance and implementation.
b. Pulse-Position Modulation (PPM) is a form of signal modulation in which M message bits are encoded by transmitting a signal pulse in one of possible required time-shifts. PPM is more power-efficient but has a lower spectral efficiency.
c. Orthogonal Frequency-Division Multiplexing (OFDM) is a method of encoding digital data on multiple carrier frequencies. This is a new approach to transmission
d. Color shift keying (CSK) is an Intensity Modulation (IM) scheme where signals are encoded into colour intensities emitted by red, green and blue (RGB) LEDs. In CSK, incoming bits are mapped on to the instantaneous chromaticities of the coloured LEDs while maintaining a constant average perceived colour. Through combination of different colours of light, the output data can be carried by the colour itself and hence the intensity of the output can be near constant (Mohamed et al,2016)

TABLE 1: COMPARISON OF DIFFERENTLI-FI MODULATION TECHNIQUES

PARAMETERS	OOK	PPM	OFDM	CSK
Bit rate, Rb	$1x10^6$	$1x10^6$	-	20mbps
Power Efficiency(Ep)	Low	High	Moderate	Low
No. of bits or bit resolution n(M)	10^3	M=3	256(Number of subcarriers)	-
Spectral Efficiency(Es)	High	Low	High	Moderate
Samples per symbols	10	250	128(Number of symbols)	number of samples (up to 25)
Bit duration, Tb	10^{-6}	10^{-6}	-	-
System Complexity	Low	Moderate	High	High
Eb/No	1:10	-10:5	[0:1:15]	-
Sampling time,Ts	$10-^7$	$0.375x10^{-6}$	-	oversampling rate of 25 samples per symbol

2. APPLICATIONS OF LI-FI

Li-Fi is a potential candidate for applications such as intelligent transportation systems, indoor positioning and the Internet of Things (IoT). It extends the capabilities of wireless communications.
There are other applications of Li-Fi which includes

a. Replacement of Wi-Fi in the airplanes because the RF waves from Wi-Fi will interfere with the pilot radio.
b. Delivery of information on prices in artworks collection, listening to an audio tour and streaming auctions of peoples work in Museum.
c. Provision of Non-interference signal in the operating rooms of the hospital unlike Wi-Fi that block signals from monitoring equipment.
d. Accurate monitoring of temperature, demand and grid integrity in smart power plants.
e. Operation in underwater for communication unlike Wi-Fi that fails completely
f. Internet connectivity in tunnels and subway stations

3. Li-Fi MISCONCEPTIONS

There are many misconceptions about Li-Fi which includes
a. Li-Fi as a Line of Sight technology: It is not true because by using an OFDM, IM/direct detection (DD) modulation scheme high data rate can be achieved.
b. Li-Fi does not work in sunlight conditions: Constant sunlight can be removed using electrical filters. In fact, sunlight is even hugely beneficial as it enables solar cell based Li-Fi receivers where the solar cell acts as data receiver device and at the same time harvests sunlight as energy.
c. Lights cannot be dimmed: Advanced modulation techniques such as Enhanced Unipolar OFDM can enable Li-Fi to operate at very low light output levels while maintaining high data rates.
d. Li-Fi is for downlink only: Li-Fi can used for uplink communication through the help of infrared spectrum that lends itself perfectly for the uplink.

4. COMPARISON OF LI-FI AND WI-FI

Both system are promising technology that can be used together to achieve high data rate.

Table 2: COMPARISON BETWEEN LI-FI AND WI-FI

S/N	PARAMETER	LI-FI	WI-FI
1.	Speed for data transfer	About 1 Gbps	54-250 Mbps
2.	Bandwidth	High due to broad spectrum	Low
3.	Range	10 meters (based on light intensity)	20-100 meters
4.	Data density	High	Low
5.	Security	High security due to non-penetration of light through walls	Less secure due to transparency
6.	Reliability	Medium	Medium
7.	Technology	Present IrDA compliant devices	WLAN802.11a/b/g/n/ac/ad standard compliant devices
8.	Device-to-device connectivity	High	High
9.	Transmit/receive power	High	Medium
10.	Ecological Impact	Low	Medium
11.	Spectrum Range	Visible Spectrum Range	Radio spectrum range
12.	Obstacle interference	High	Low
13	Operating Frequency	Hundreds of Tera Hz	2.4 GHz, 4.9GHz and 5GHz
14.	Latency	In the order of microseconds	In the order of milliseconds
15.	Network topology	Point-to-point	Point-to-multipoint

III. CONCLUSION

There is limited availability of RF spectrum due to the growing number of people and their many devices accessing the wireless internet making it more difficult to get a reliable and high-speed signal. The concept of Li-Fi is currently attracting a great deal of interest and research in areas such as multiuser access, interference mitigation and mobility support. If it can be put into practical use, then it becomes a future technology for wireless data communication. Every bulb can be used like a Wi-Fi hotspot to transmit wireless data and even proceed towards a cleaner, greener, safer and brighter global community.

REFERENCES

[1]. Ashwini B.N; Avikumar R; Jyothi M.P; (2016), *"Wireless Data Transmission Through Led"*, International Journal of Engineering Research in Electrical and Electronic Engineering, Volume 2, Issue 5, Pp 42-45.

[2]. Mahendran R; (2016), *"Integrated Li-Fi for smart communication through illumination"*, International Conference on Advanced Communication Control and Computing Technologies (ICACCCT), Pp 53-56.

[3]. Mohamed SufyanIslim and HaraldHaas (2016). *"Modulation Techniques for Li-Fi"*, ZTE Communications ,Vol.13, No.2, pp.29-40

[4]. Harald Haas (2016), *"Li-Fi: Conceptions, Misconceptions and Opportunities"*, IEE ISBN: 978-1-5090-1906-9, Pp 680-681.

[5]. HaraldHass (2018), "*Li-Fi is a paradigm- shifting 5G technology*", Elsevier Reviews in Physics, Vol. 3, pp. 26-31